(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
7 September 2001 (07.09.2001)

PCT

(10) International Publication Number
WO 01/65581 A1

(51) International Patent Classification[7]: H01H 51/22, 33/66, 51/20

(21) International Application Number: PCT/IB01/00287

(22) International Filing Date: 1 March 2001 (01.03.2001)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
00/1066 2 March 2000 (02.03.2000) ZA

(71) Applicant *(for all designated States except US)*: **CRUISE, Rupert, John** [ZA/ZA]; 18 Coloretto, 16 Bompas Road, Dunkeld West, 2196 Johannesburg (ZA).

(71) Applicants and
(72) Inventors: **POSEN, Kevin** [ZA/ZA]; 6 Rubenstein Drive, Sandown, 2196 Johannesburg (ZA). **FINN, Lindy, Kim** [ZA/ZA]; 28 Komati Avenue, Gallo Manor, 2052 Johannesburg (ZA). **MILLER, Craig, Elle** [ZA/ZA]; 35 Summerway, Glenhazel, 2192 Johannesburg (ZA).

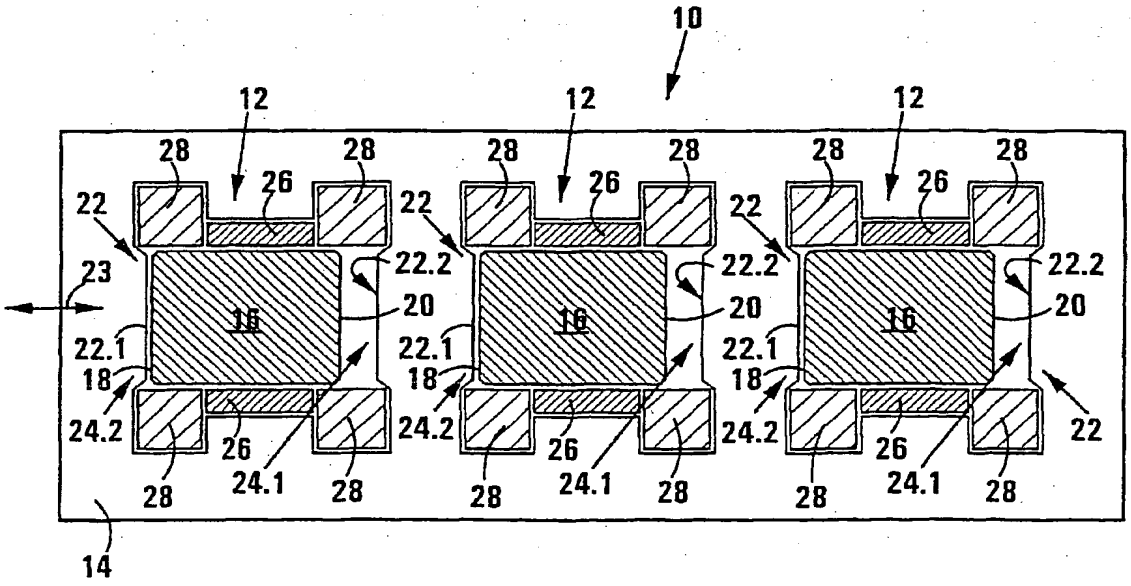
(74) Agent: **VIVIER, Garth**; Adams & Adams, Adams & Adams Place, 1140 Prospect Street, Hatfield, 0001 Pretoria (ZA).

(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

[Continued on next page]

(54) Title: A MAGNETIC ACTUATOR



(57) Abstract: This invention relates to a magnetic actuator which includes a plunger having a leading end and a trailing end, and a core which together with the plunger provides a magnetic flux path along which the plunger is displaceable. The plunger is displaceable between a first operative position in which a trailing airgap between the trailing end of the plunger and the core is closed, and a leading airgap between the leading end of the plunger and the core is open, and a second displaced operative position in which the trailing airgap is open and the leading airgap is closed. The magnetic actuator also includes a plunger holding magnetic flux source for holding the plunger in either of its operative positions, and a pair of simultaneously energizable plunger displacing magnetic flux sources of the same polarity spaced along the magnetic flux path for displacing the plunger between its two operative positions.

WO 01/65581 A1

Published:
— *with international search report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

A MAGNETIC ACTUATOR

THIS INVENTION relates the operation of a magnetic actuator. It also relates to a magnetic actuator, to a magnetic actuator assembly, and to electrical switch gear incorporating such an assembly.

The applicants have found that magnetic actuators of which they are aware use heavy currents on activation. The applicants believe that an actuator having a more modest activation current requirement may be devised.

Accordingly, in a magnetic actuator which includes a plunger having a leading end and a trailing end and which is movable along a magnetic flux path provided by a magnetic core and the plunger, between a first operative position in which a trailing airgap between the core and the trailing end of the plunger is closed, and a leading airgap between the core and the leading end of the plunger is open, and a second operative position in which the leading airgap is closed and the trailing airgap is open,

the invention according to a first aspect, provides a method of operating the actuator which includes the steps of

providing a plunger holding magnetic flux source between the

airgaps for holding the plunger in one or other of its two operative positions; and

simultaneously energizing a pair of plunger displacing magnetic flux sources of the same polarity and spaced apart along the magnetic flux path, thereby to displace the plunger between its first operative position and its second operative position, and thereby to open and close the trailing and leading airgaps.

The simultaneous energizing of the plunger displacing magnetic flux sources may take place momentarily. The energizing of the plunger displacing magnetic flux sources may last at the most until closure of the leading or trailing airgap, as the case may be.

According to another aspect, the invention provides a magnetic actuator which includes

a plunger having a leading end and a trailing end;

a core which together with the plunger provide a magnetic flux path along which the plunger is displaceable relative to the core, the plunger having a first operative position in which a trailing airgap between the trailing end of the plunger and the core is closed, and a leading airgap between the leading end of the plunger and the core is open, and a second displaced operative position in which the trailing airgap is open and the leading airgap is closed;

a plunger holding magnetic flux source between the airgaps for holding the plunger in one or the other of its two operative positions; and

a pair of simultaneously energizable plunger displacing magnetic flux sources of the same polarity spaced along the magnetic flux path for displacing the plunger between its two operative positions.

The plunger may be elongate, its leading end being axially spaced from its trailing end. The core may define a compartment axially longer than the plunger, within which the plunger is held captive and is axially displaceable between its operative positions.

The plunger holding flux source may be provided by at least one permanent magnet, eg. a toroidal permanent magnet, mounted between ends of the plunger.

In a preferred embodiment the plunger holding flux source is provided by a pair of permanent magnets mounted on opposite sides of the plunger between its ends.

The permanent magnets may be arranged to have like poles on opposite sides of the plunger.

The plunger displacing magnetic flux sources of the same polarity, may be provided by a pair of coils axially spaced proximate the ends of the compartment and coaxial with the plunger. There may also be provided energizing means for energizing them simultaneously. The energizing means may be operable momentarily. The coils may be connected in series.

The invention extends also to a magnetic actuator assembly which includes

a plurality of magnetic actuators as described, arranged such that their plungers are spaced and in alignment;

mechanical connecting means mechanically interconnecting at least

two of the plungers, thereby ensuring that they are displaceable in unison; and

electrical connecting means, electrically interconnecting at least two of the plunger displacing magnetic flux sources, to ensure that they are all simultaneously energizable. It is to be appreciated that , although it is advantageous to energize the displacing magnetic flux sources at substantially the same time, they can be energized at slightly differing times provided that at some point in time they are all energized at the same time or substantially simultaneously. This however is not a preferred situation.

In the assembly the cores may be integral with one another and may have plunger compartments which are spaced and aligned. Each plunger may be held captive and may be displaceable in its own compartment; and the mechanical connecting means may include a plunger rod connected to at least two of the plungers, the plunger rod being displaceable with the plungers relative to the core. The core may have a guide passage intersecting the compartments to accommodate the plunger rod.

The invention extends also to electrical switch gear which includes

a pair of spaced contactors having open and closed operative positions, at least one of the contactors being movable relative to the other;

a magnetic actuator as described above; and

interconnecting means interconnecting the plunger to the contactors, for operative displacement of the contactors when the

plunger is displaced.

The interconnecting means may include a lever pivotally mounted relative to the core, and having its working arm connected to at least one of the contactors, and having its effort arm connected to the plunger.

The invention extends further to electrical switch gear which includes

a pair of spaced contactors having open and closed operative positions, at least one of the contactors being movable relative to the other;

a magnetic actuator assembly as described above; and

interconnecting means interconnecting the mechanical connecting means to the contactors, for operative displacement of the contactors when the plungers are displaced in unison.

The interconnecting means may include a lever pivotally mounted relative to the core, the lever, having its working arm connected to at least one of the contactors, and having its effort arm connected to the mechanical connecting means.

Further features of the invention will become apparent from the following description by way of example, of a magnetic actuator assembly, with reference to the accompanying diagrammatic drawings.

In the drawings,

Figure 1 shows a longitudinal sectional view through part of a magnetic actuator assembly, in accordance with the invention;

Figure 2 shows a longitudinal sectional view corresponding to Figure 1, including an indication of the polarities of the magnetic flux sources;

Figure 3 shows a three dimensional view of the assembly shown in Figures 1 and 2 of the drawings, in which its core windings are visible;

Figure 4 shows a view corresponding to Figure 3 with the core windings removed;

Figure 5 shows a schematic circuit diagram of a switching arrangement for energizing the core windings or coils of a magnetic actuator assembly in accordance with the invention;

Figure 6 shows the flux distribution in a longitudinal sectional view of the assembly, with the plungers in their first operative position and the coils unenergized;

Figure 7 shows a view corresponding to Figure 6, but immediately after the coils have been energized and momentarily before displacement of the plungers;

Figure 8 shows a view corresponding to Figure 7, but with the coils now fully energized and the plungers about to move;

Figure 9 shows a view corresponding to Figure 8, but immediately after the plungers have been displaced to their second operative position;

Figure 10 shows a view corresponding to Figure 9, but with the plungers held in their second operative position, and with the coils unenergized; and

Figure 11 shows electrical switch gear in accordance with the invention, which incorporates a magnetic actuator assembly, also in accordance with the invention.

Referring to the drawings, in Figures 1 and 2 of the drawings, reference numeral 10 generally indicates part of a magnetic actuator assembly, in accordance with the invention. The magnetic actuator assembly shown, has three magnetic actuators, also in accordance with the invention, generally indicated by reference numeral 12. Each actuator 12 has a magnetic flux path defining means which is in the form of a ferromagnetic core 14, e.g. a steel core, and ferromagnetic plungers 16. Each plunger 16 has a trailing end 18 and an opposed leading end 20. The plungers 16 are displaceably mounted relative to the core 14 within core compartments 22. The compartments 22 have opposed end walls 22.1 and 22.2, the end wall 22.1 being a trailing end wall, and the end wall 22.2 being a leading end wall. The plungers 16 are displaceable within the compartments 22, in the direction shown by arrow 23. The spacing between the trailing ends 18 and the leading ends 20 of the plungers 16 is smaller than the spacing between the end walls 22.1 and 22.2. In other words the compartments 22 are axially longer than the plungers 16.

Thus in a first operative position, as indicated in Figures 1 and 2 of the drawings, open leading air gaps 24.1 are defined between the leading ends 20 of the plungers 16 and the end walls 22.2 of the core compartments 22. As the plungers 16 are displaced within the core compartments 22, to a second operative position, the leading airgaps 24.1 close, and trailing airgaps 24.2 between the end walls 22.1 of the compartments 22, and the trailing ends 18 of the plungers 16 become open. The trailing airgaps 24.2, when open, can be clearly seen in Figures 9 and 10 of the drawings. When the plungers 16 are in their first operative position, the trailing airgaps 24.2 are closed, and the leading

airgaps 24.1 are open. See Figures 1, 2, 4, 6, 7, 8, and 11. When the plungers 16 are in their second operative position, the trailing airgaps 24.2 are open and the leading airgaps 24.1 are closed. See Figures 9 and 10 of the drawings.

The plungers 16 are mechanically interlinked via mechanical connecting means in the form of a plunger rod 40, which runs along the length of the actuator assembly 10. The rod 40 ensures that the plungers 16 are all displaced in unison in the direction of arrow 23 when operated (see Figure 11). It is to be appreciated that any two or more of the plungers 16 may be interconnected and each plunger 16, or combinations of plungers 16, may dependently or independently drive an associated switching device.

Each actuator 12 also includes a plunger holding flux source in the form of pairs of permanent magnets 26 mounted adjacent the core compartments 22 on opposite sides of the plungers 16, between the airgaps 24.1 and 24.2. The magnets 26 are arranged with their polarities extending transversely to the direction of displacement of the plungers 16, and such that like poles of the magnets 16 are on opposite sides of the plungers 16, as indicated by way of example, in Figure 2. The result is that each plunger 16 provides a magnetic flux path for the magnets 26. These permanent magnets 26 are the plunger holding magnetic flux sources for holding the plungers 16 in the one or the other of their operative positions (see in particular Figures 1 and 10). It is to be appreciated that each pair of magnets 26 may be defined by a single toroidal permanent magnet.

The actuators 12 also each have a pair of plunger displacing flux sources in the form of a pair of axially spaced core windings or coils 28, mounted adjacent each of the end walls 22.1 and 22.2 of the compartments 22, and co-axial with the direction of displacement of the plungers 16, as shown by arrow 23. The coils 28 can be seen in Figure 3. The coils 28 are wound and connected such that currents flowing through the coils produce plunger displacing fluxes of the same polarity in the plungers 16 and core 14.

In this example of the invention, the coils 28 are connected as shown in the circuit diagram of Figure 5, in which the pairs of wound coils are generally indicated by reference numeral 30. Here the coils 28 in a pair associated with each actuator 12, are connected in series with each other, and the pair of coils 30 of each actuator are connected in parallel with the pair of coils 30 of the other actuators 12. The coils 28 are energizable via a DC power source 32 which is applied across the pair of coils 30 through a switching bridge 34. The bridge 34 is configured such that when the switches 34.1 and 34.2 are closed and when the switches 34.3 and 34.4 are open the current will flow in one direction through the coils 28, and when 34.1 and 34.2 are open and 34.3 and 34.4 are closed, the current will flow in the opposite direction.

The operation of the magnetic actuator assembly 10 is demonstrated in Figures 6 through 10. In Figure 6, the coils 28 are shown to be unenergized and the plungers 16 are shown to be held in the first operative position, with the trailing ends 18 of the plungers 16 adjacent the end walls 22.1 of the compartments 22, the trailing airgaps 24.2 being closed. The leading airgaps 24.1 defined between the leading

ends 20 of the plungers 16 and the opposing end walls 22.2 of the compartments 20, are in the open position. In this stable position the permanent magnets 26 produce a concentrated flux distribution 36 adjacent the end walls 22.1 and bridging the closed airgap 24.2 (see Figure 6). The magnets 26 are arranged such that they produce balanced magnetic forces through the plungers 16, and core 14. However the flux will flow along the path which provides the highest magnetic permeability, and this is defined by the path through the closed airgaps 24.2. Thus the plungers 16 are held in their first operative positions by the magnetic flux concentrations 36 bridging the closed airgaps 24.2. Accordingly, no electrical power is required by the actuator 12 to maintain plungers 16 in their first operative positions.

Once the coils 28 have been energized with a suitable polarity to oppose the polarity of the flux at the closed airgaps 24.2, as shown in Figures 7, 8, 9, plunger displacing magnetic fluxes are produced in the plungers 16 and the core 14 by the coils 28 which overpower the holding flux 36 produced by the permanent magnets 26 adjacent the end walls 22.1 and adjacent the trailing ends 18 of the plungers 16. The coils 28 when energized, provide a high flux density across the open leading airgaps 24.1 and a low flux density across the trailing airgaps 24.2. This results in a magnetic force from left to right in the drawings in the direction of arrow 23 which causes displacement of the plungers 16 from their first operative positions into their second operative positions.

As the leading ends 20 of the plungers 16 approach the end walls 22.2 defining the second operative positions, the higher magnetic

permeability associated with the now diminished leading airgaps 24.1 tends to increase the concentration of flux adjacent the end walls 22.2, thereby to cause accelerated displacement of the plungers 16. It is therefore possible to de-energize the coils 28 before the leading ends 20 of the plungers 16 reach the end walls 22.2 and before they close the leading airgaps 24.1. The coils 28 therefore need only be energized momentarily, to achieve displacement of the plungers 16. That is the coils 28 are typically energized for a period lasting at the most until the leading airgaps 24.1 are closed.

Once the leading ends 20 of the plungers 16 reach the end walls 22.2, the plungers 16 are once again held in position by the holding fluxes of the permanent magnets 26 in the second operative position. The holding fluxes in this operative position is indicated by reference numeral 38, bridging the now closed airgaps 24.1. It will be noted that adjacent magnetic actuator 12 shares a common wall of the core 14. Further, the core 14 may have different shapes and configurations dependent upon the selected design of the actuator 12.

It is possible to displace the plungers 16 back into the first operative position by reversing the direction of current flow through the coils 28 which will produce a magnetic force in the plungers 16 and core 14 in the opposite direction, that is from right to left in the drawings. For such reverse operation, the leading ends 20 of the plungers 16 then become trailing ends, and the trailing ends 18 become leading ends.

In Figure 11, reference numeral 50 generally indicates electrical switch gear assembly, also in accordance with the invention,

including an actuator assembly 10. The assembly includes contactors 42 and mechanical connecting means in the form of a plunger rod 40, mechanically interconnecting the plungers 16 of the actuator 10 via a guide passage 43. The rod 40 is displaceable in the direction of arrow 23, relative to the core 14. The rod 40 is in turn coupled by a lever 41 to the contactors 42. The coils 28 may therefore be energized to cause the connecting rod 40 to either open or close the contactors 42, as indicated by arrows 23.1.

The inventors believe that the invention, as described, provides an improved magnetic actuator 10 and magnetic actuator assembly 50 which make efficient use of the actuator core material and reduces the required current carrying winding material. The use of a pair of simultaneously momentarily energizable coil windings 30 which spread and re-distribute the flux in the core 14 makes effective use of the core material. Thus the overall flux densities throughout the core 14 are reduced over that which would normally be required. The volume and hence the cost of the core material are thus reduced. Furthermore, the use of spaced simultaneously energizable coil windings 28 reduces the maximum magnetomotive force required to cause displacement of the plungers 16. This results in a reduction in the volume of current carrying coil material (e.g. copper) in each of the coil windings. This further reduces the cost of the manufacture of the actuator.

CLAIMS:

1. In a magnetic actuator which includes

a plunger having a leading end and a trailing end and which is movable along a magnetic flux path provided by a magnetic core and the plunger, between a first operative position in which a trailing airgap between the core and the trailing end of the plunger is closed, and a leading airgap between the core and the leading end of the plunger is open, and a second operative position in which the leading airgap is closed and the trailing airgap is open,

there is provided a method of operating the actuator which includes the steps of

providing a plunger holding magnetic flux source between the airgaps for holding the plunger in one or other of its two operative positions; and

simultaneously energizing a pair of plunger displacing magnetic flux sources of the same polarity and spaced apart along the magnetic flux path, thereby to displace the plunger between its first operative position and its second operative position, and thereby to open and close the trailing and leading airgaps.

2. A method as claimed in Claim 1, in which the simultaneous energizing of the plunger displacing magnetic flux sources takes place momentarily.

3. A method as claimed in Claim 2, in which the energizing of the plunger displacing magnetic flux sources lasts at the most until closure of the airgap.

4. A magnetic actuator, which includes

a plunger having a leading end and a trailing end;

a core which together with the plunger provide a magnetic flux path along which the plunger is displaceable relative to the core, the plunger having a first operative position in which a trailing airgap between the trailing end of the plunger and the core is closed, and a leading airgap between the leading end of the plunger and the core is open, and a second displaced operative position in which the trailing airgap is open and the leading airgap is closed;

a plunger holding magnetic flux source between the airgaps for holding the plunger in one or the other of its two operative positions; and

a pair of simultaneously energizable plunger displacing magnetic flux sources of the same polarity spaced along the magnetic flux path for displacing the plunger between its two operative positions.

5. A magnetic actuator as claimed in Claim 4, in which the plunger is elongate, its leading end being axially spaced from its trailing end, and in which the core defines a compartment axially longer than the plunger, and within which the plunger is held captive and is axially displaceable between its operative positions.

6. A magnetic actuator as claimed in Claim 5, in which the plunger holding flux source is provided by at least one permanent magnet mounted between ends of the plunger.

7. A magnetic actuator as claimed in Claim 5 or Claim 6, in which the plunger holding flux source is provided by a pair of permanent magnets mounted on opposite sides of the plunger between its ends.

8. A magnetic actuator as claimed in Claim 7, in which the permanent magnets are arranged to have like poles on opposite sides of the plunger.

9. A magnetic actuator as claimed in any one of the preceding claims 5 to 8 inclusive, in which the plunger displacing magnetic flux sources of the same polarity, are provided by a pair of coils axially spaced proximate the ends of the compartment and coaxial with the plunger; and

in which there is provided energizing means for energizing them substantially simultaneously.

10. A magnetic actuator as claimed in Claim 9, in which the energizing means are operable momentarily.

11. A magnetic actuator as claimed in Claim 9 or Claim 10, in which the coils are connected in series.

12. A magnetic actuator assembly, which includes

a plurality of magnetic actuators as claimed in any one of the claims 9 to 11 inclusive, arranged such that their plungers are spaced and in alignment;

mechanical connecting means mechanically interconnecting at least two of the plungers, thereby ensuring that they are displaceable in unison; and

electrical connecting means, electrically interconnecting at least two of the plunger displacing magnetic flux sources, to ensure that they are all simultaneously energizable.

13. A magnetic actuator assembly as claimed in Claim 12, in which the cores are integral with one another and have plunger compartments which are spaced and aligned, and in which each plunger is held captive and is displaceable in its own compartment; and

in which the mechanical connecting means includes a plunger rod connected to at least two of the plungers, the plunger rod being displaceable with the plungers relative to the core.

14. A magnetic actuator assembly as claimed in Claim 13, in which the core has a guide passage intersecting the compartments to accommodate the plunger rod.

15. Electrical switch gear, which includes

a pair of spaced contactors having open and closed operative positions, at least one of the contactors being movable relative to the other;

a magnetic actuator as claimed in any one of the claims 4 to 11 inclusive; and

interconnecting means interconnecting the plunger to the contactors, for operative displacement of the contactors when the plunger is displaced.

16. Electrical switch gear as claimed in Claim 15, in which the interconnecting means includes a lever pivotally mounted relative to the core, and having its working arm connected to at least one of the contactors, and having its effort arm connected to the plunger.

17. Electrical switch gear, which includes

a pair of spaced contactors having open and closed operative positions, at least one of the contactors being movable relative to the other;

a magnetic actuator assembly as claimed in any one of the claims 12 to 14 inclusive; and

interconnecting means interconnecting the mechanical connecting means to the contactors, for operative displacement of the contactors when the plungers are displaced in unison.

18. Electrical switch gear as claimed in Claim 17 in which the interconnecting means includes a lever pivotally mounted relative to the core, the lever, having its working arm connected to at least one of the contactors, and having its effort arm connected to the mechanical connecting means.

19. A method of operating a magnetic actuator, substantially herein described and illustrated.

20. A magnetic actuator, substantially as herein described and illustrated.

21. A magnetic actuator assembly, substantially as herein described and illustrated.

22. Electrical switch gear, substantially as herein described and illustrated.

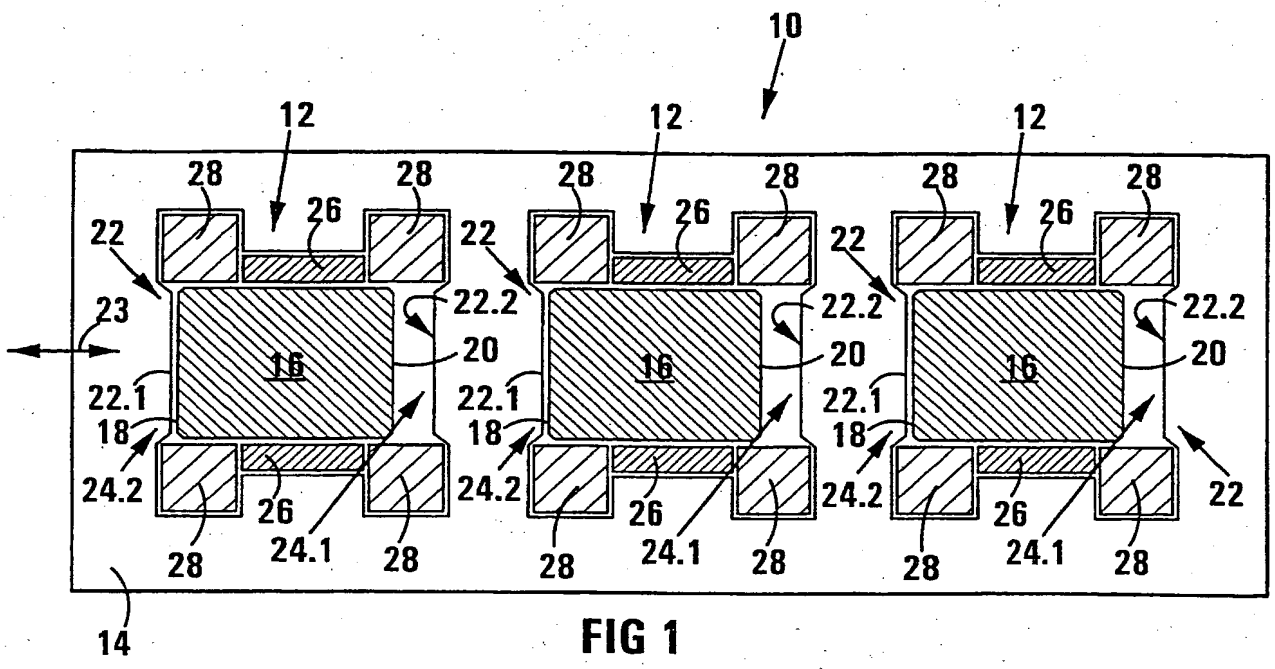


FIG 1

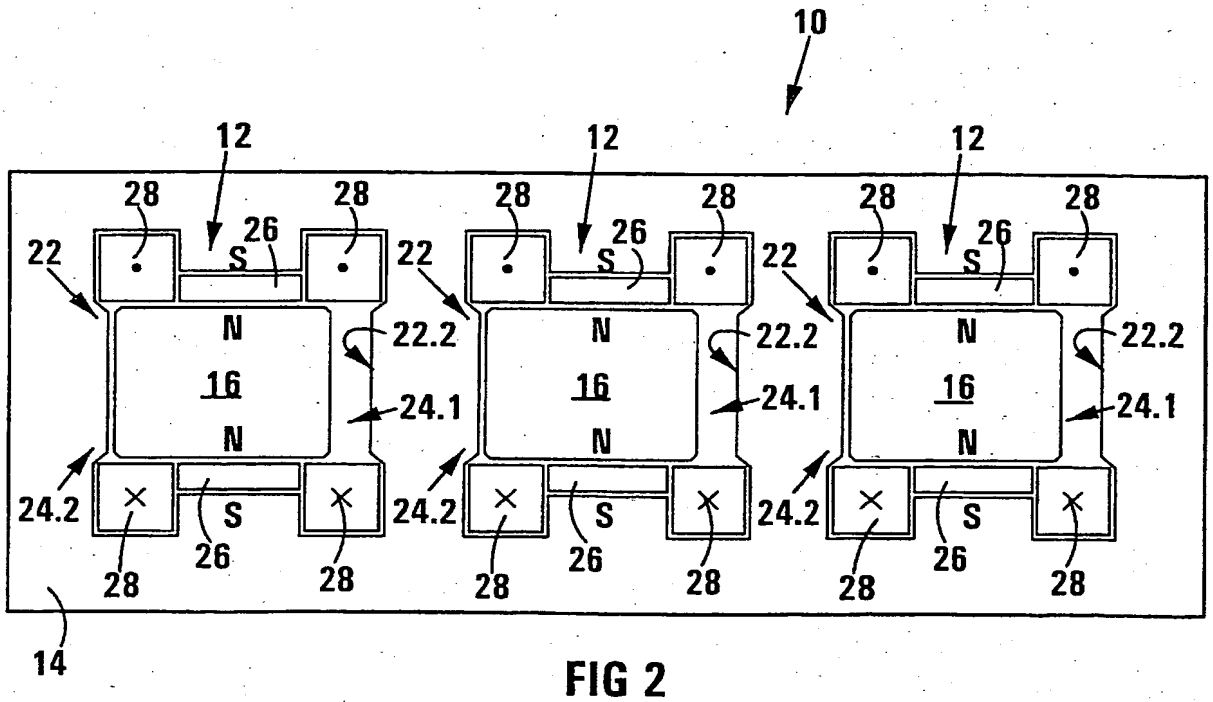


FIG 2

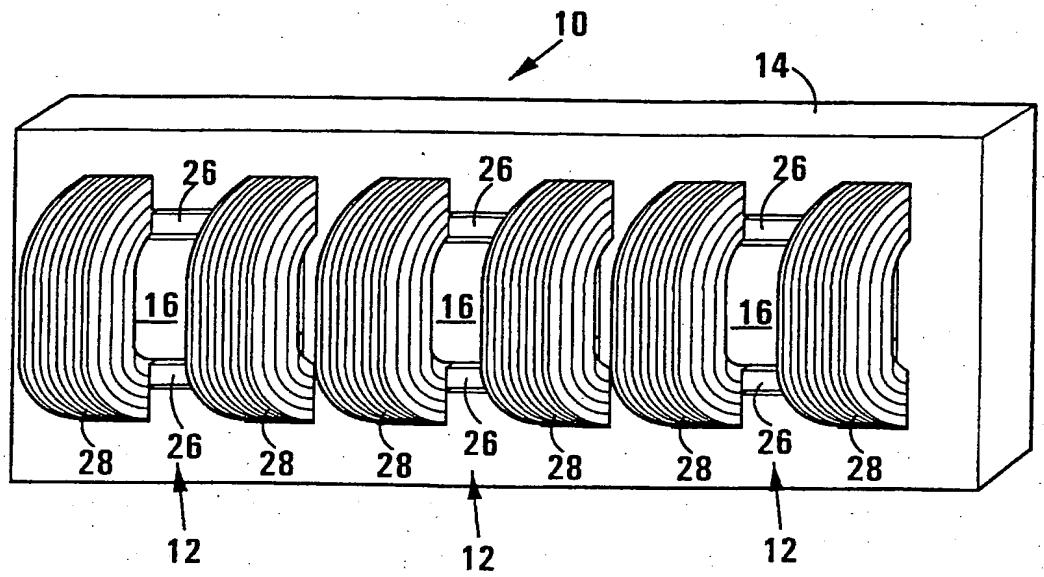


FIG 3

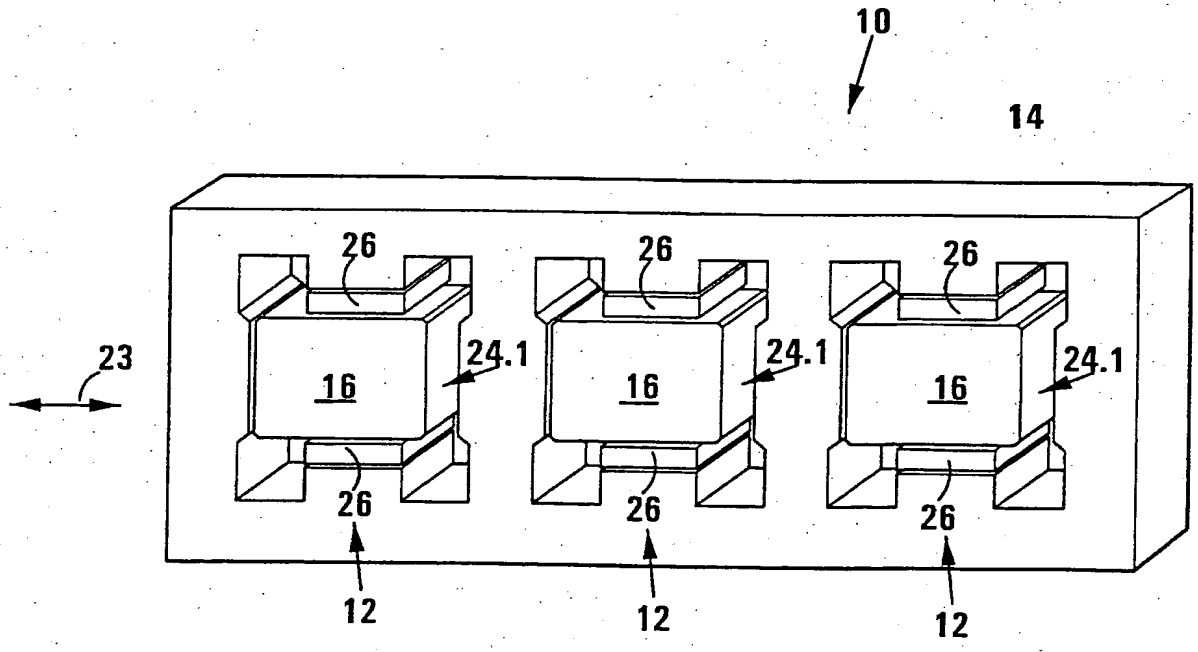


FIG 4

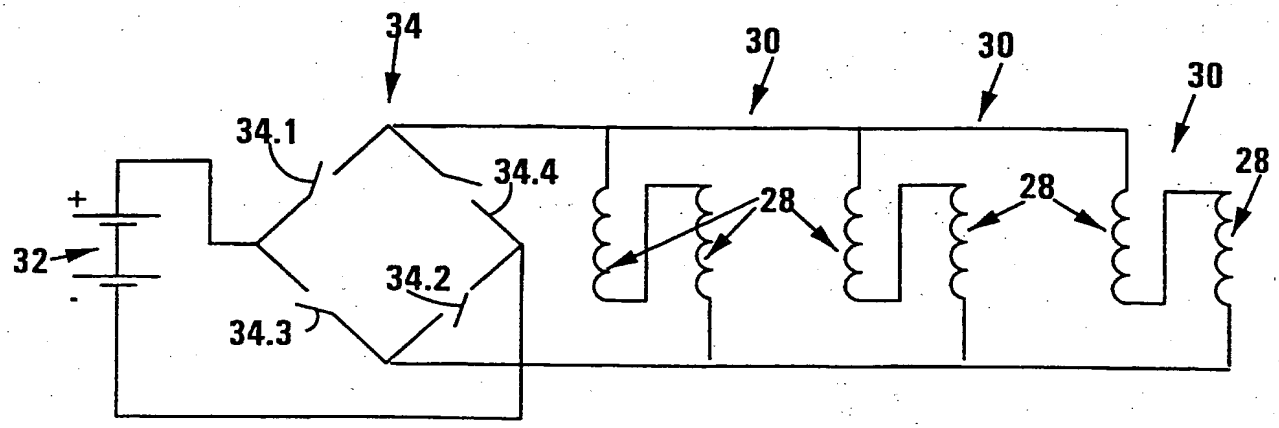


FIG 5

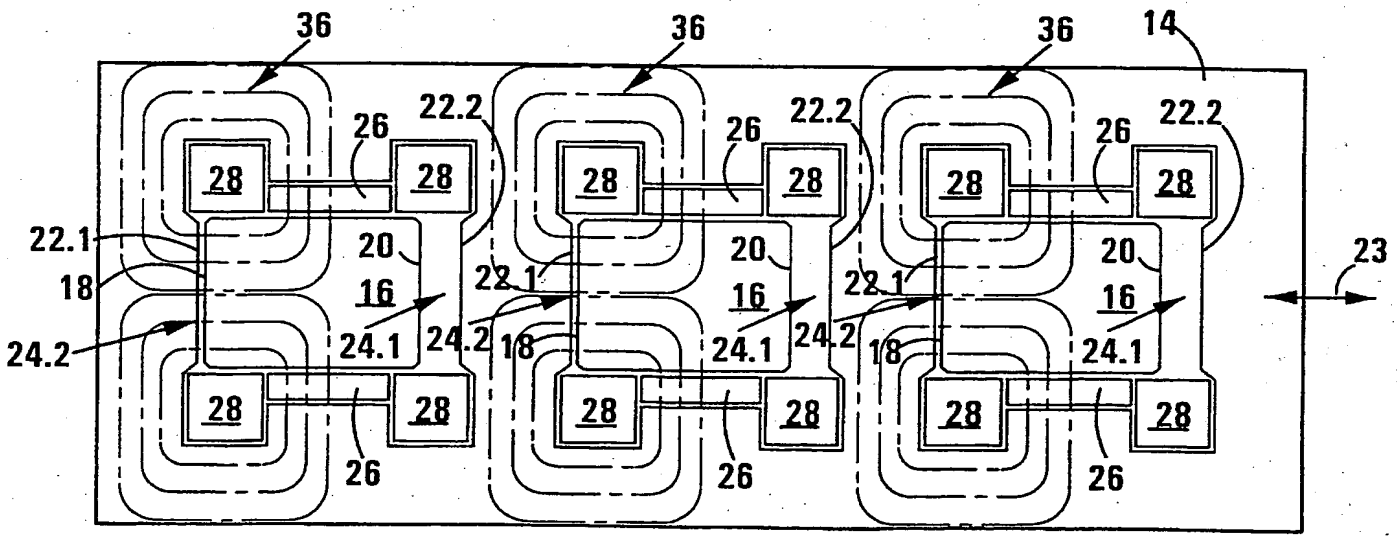


FIG 6

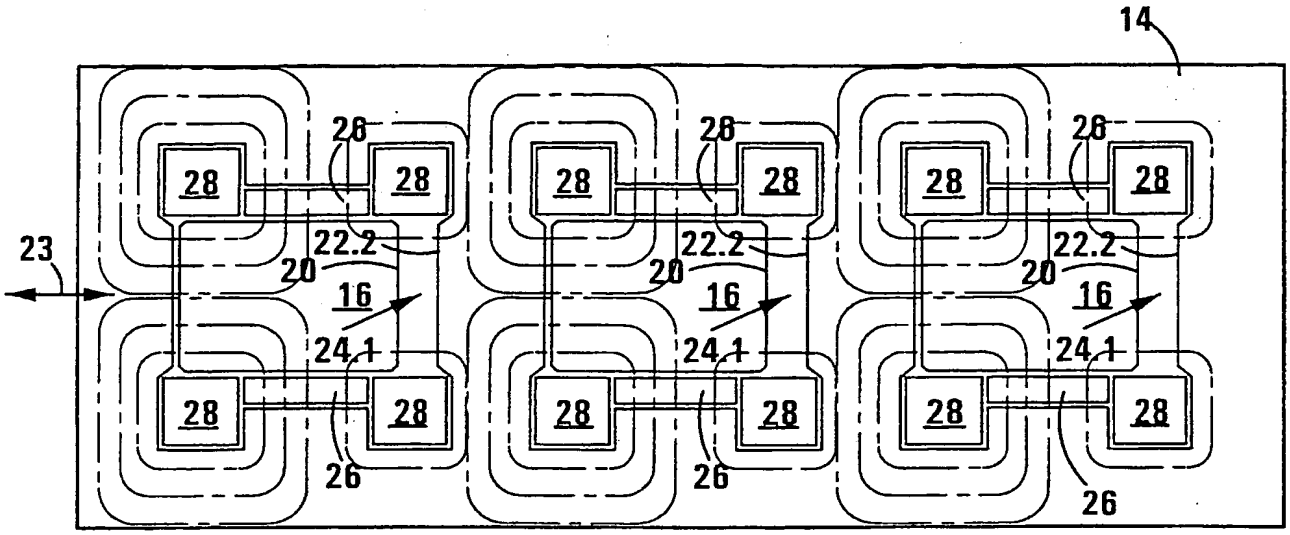


FIG 7

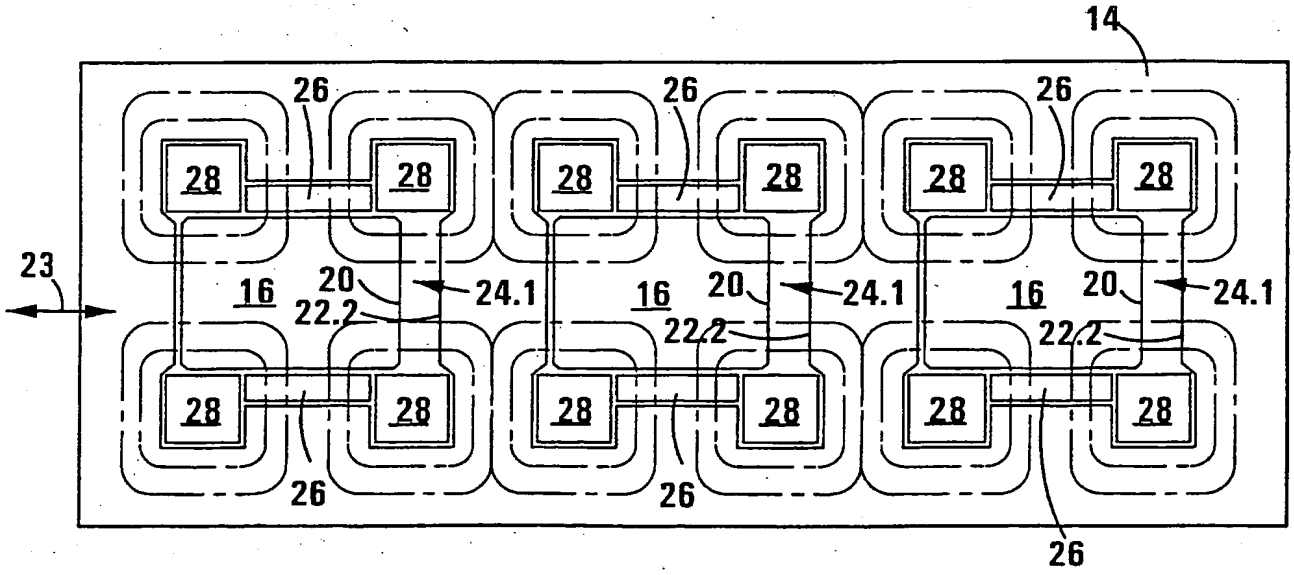


FIG 8

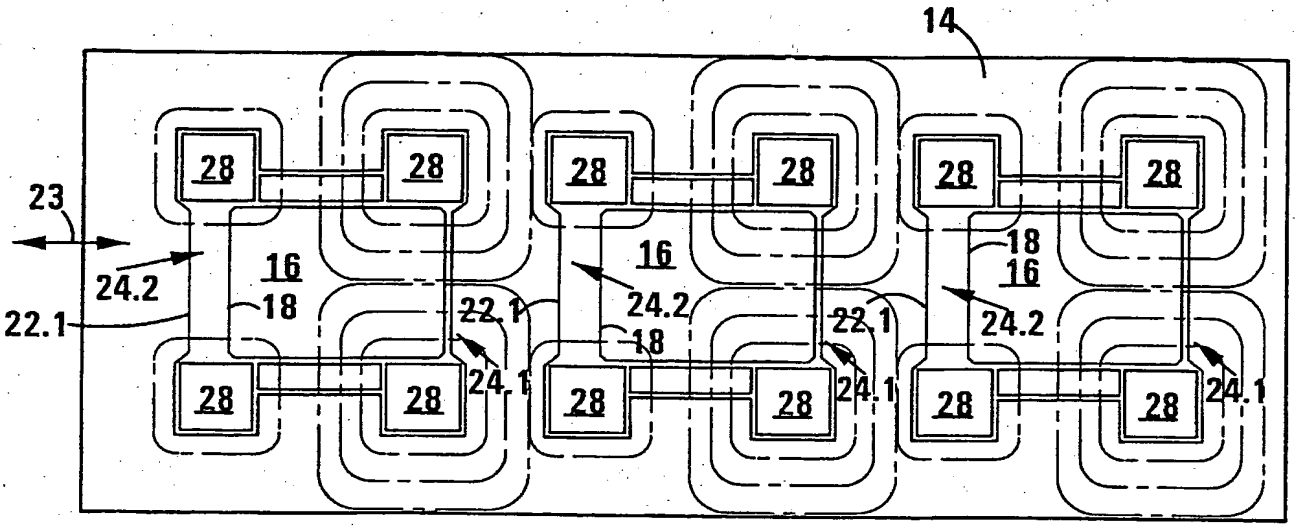


FIG 9

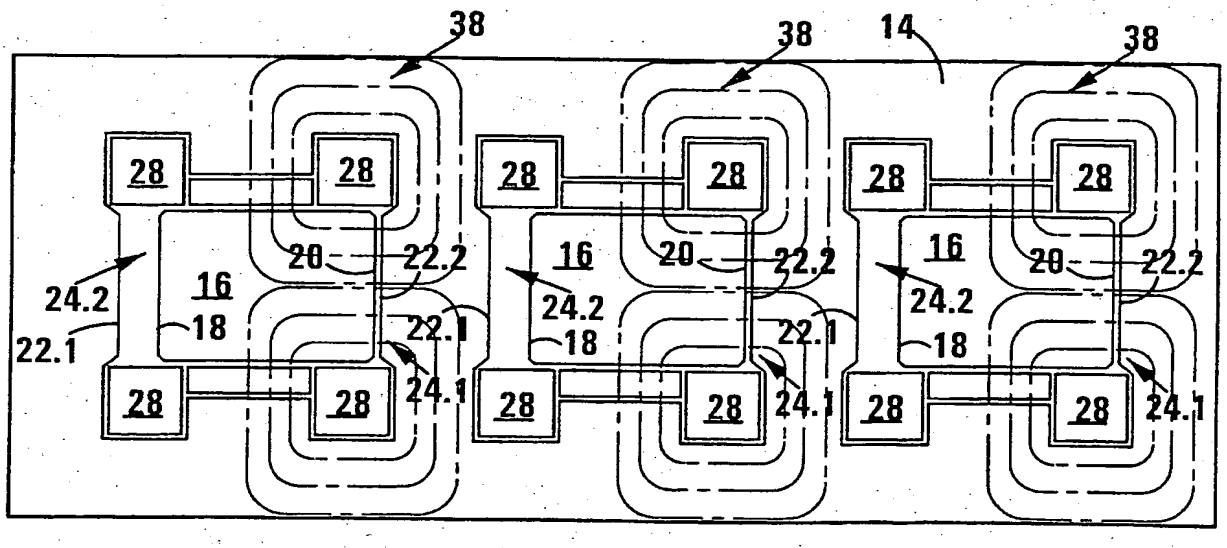


FIG 10

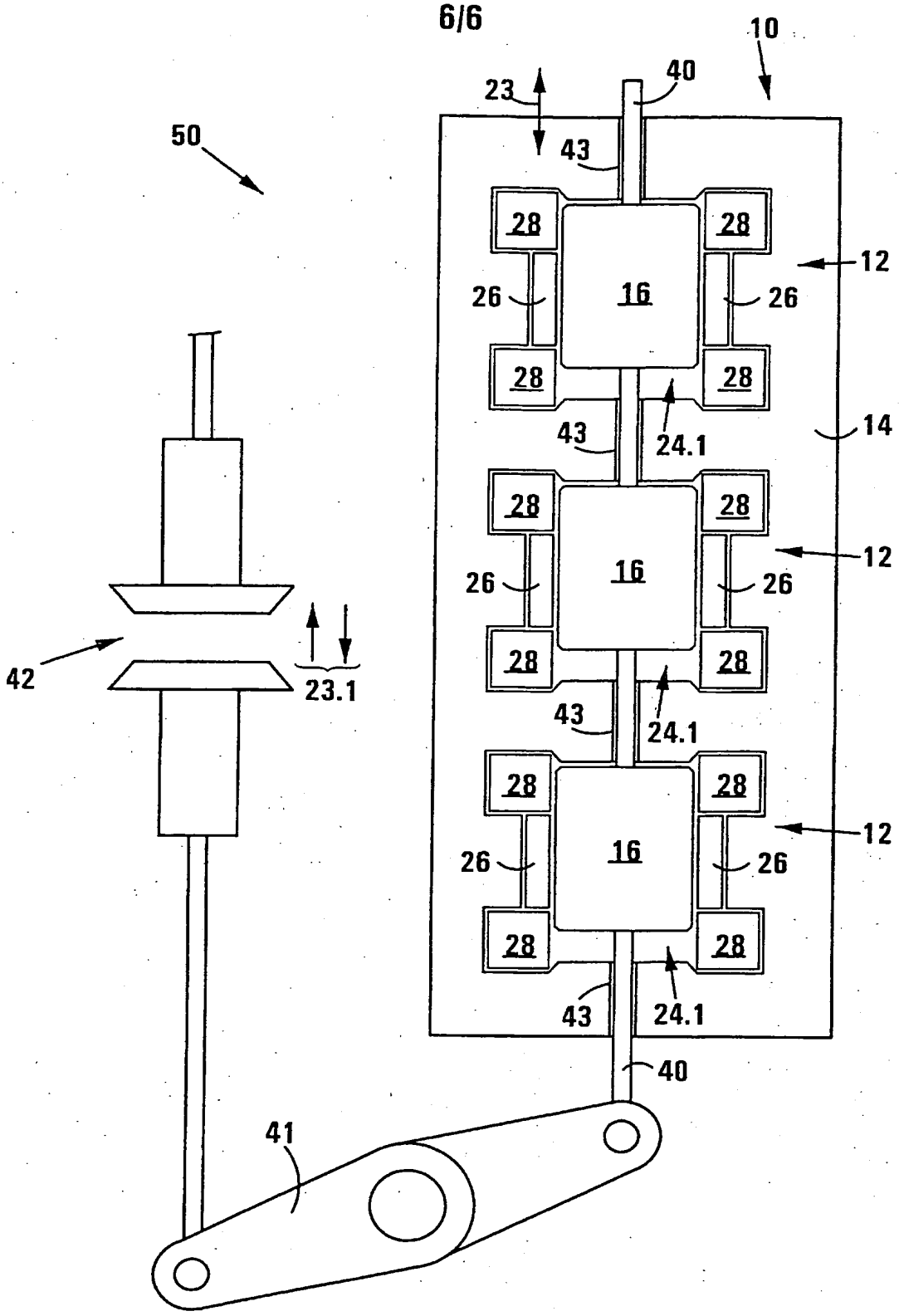


FIG 11

INTERNATIONAL SEARCH REPORT

ɔnal Application No
PCT/IB 01/00287

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H01H51/22 H01H33/66 H01H51/20

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H01H H01F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	FR 2 252 217 A (SIEMENS AG) 20 June 1975 (1975-06-20) page 5, paragraph 4 -page 6, paragraph 2; figures 1,2	1,11
A	DE 197 09 089 A (ABB PATENT GMBH) 10 September 1998 (1998-09-10) column 2, line 47 -column 3, paragraph 1; figures 1,2	1,15
A	EP 0 354 803 A (GEC ALSTHOM LTD) 14 February 1990 (1990-02-14) column 2, line 31 - line 56; figure 2	1,15
A	EP 0 867 903 A (TOKYO SHIBAURA ELECTRIC CO) 30 September 1998 (1998-09-30) figure 24	15-18

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
6 June 2001	12/06/2001

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Janssens De Vroom, P

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International Application No
PCT/IB 01/00287

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 580 285 A (GEC ALSTHOM LTD) 26 January 1994 (1994-01-26) abstract; figures 4,6	1,15

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/IB 01/00287

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
FR 2252217 A	20-06-1975	DE 2359357 A	05-06-1975
		DE 2359365 B	07-05-1975
		AU 7434274 A	29-04-1976
		BE 822719 A	28-05-1975
		CH 573654 A	15-03-1976
		DK 616374 A	14-07-1975
		IT 1025777 B	30-08-1978
		JP 50085422 A	10-07-1975
		NL 7415290 A	30-05-1975
		SE 7414772 A	29-05-1975
		ZA 7406478 A	29-10-1975
DE 19709089 A	10-09-1998	EP 0883146 A	09-12-1998
EP 0354803 A	14-02-1990	AU 4203389 A	05-03-1990
		AU 7635091 A	08-08-1991
		CN 1040886 A	28-03-1990
		WO 9001788 A	22-02-1990
		GB 2223357 A	04-04-1990
		JP 3502021 T	09-05-1991
		MT 1046 A	04-10-1990
		ZA 8906108 A	30-05-1990
EP 0867903 A	30-09-1998	JP 11072179 A	16-03-1999
		US 6020567 A	01-02-2000
EP 0580285 A	26-01-1994	AU 4166393 A	27-01-1994
		BR 9302913 A	22-02-1994
		GB 2269063 A,B	26-01-1994
		MX 9304342 A	29-04-1994
		US 5452172 A	19-09-1995